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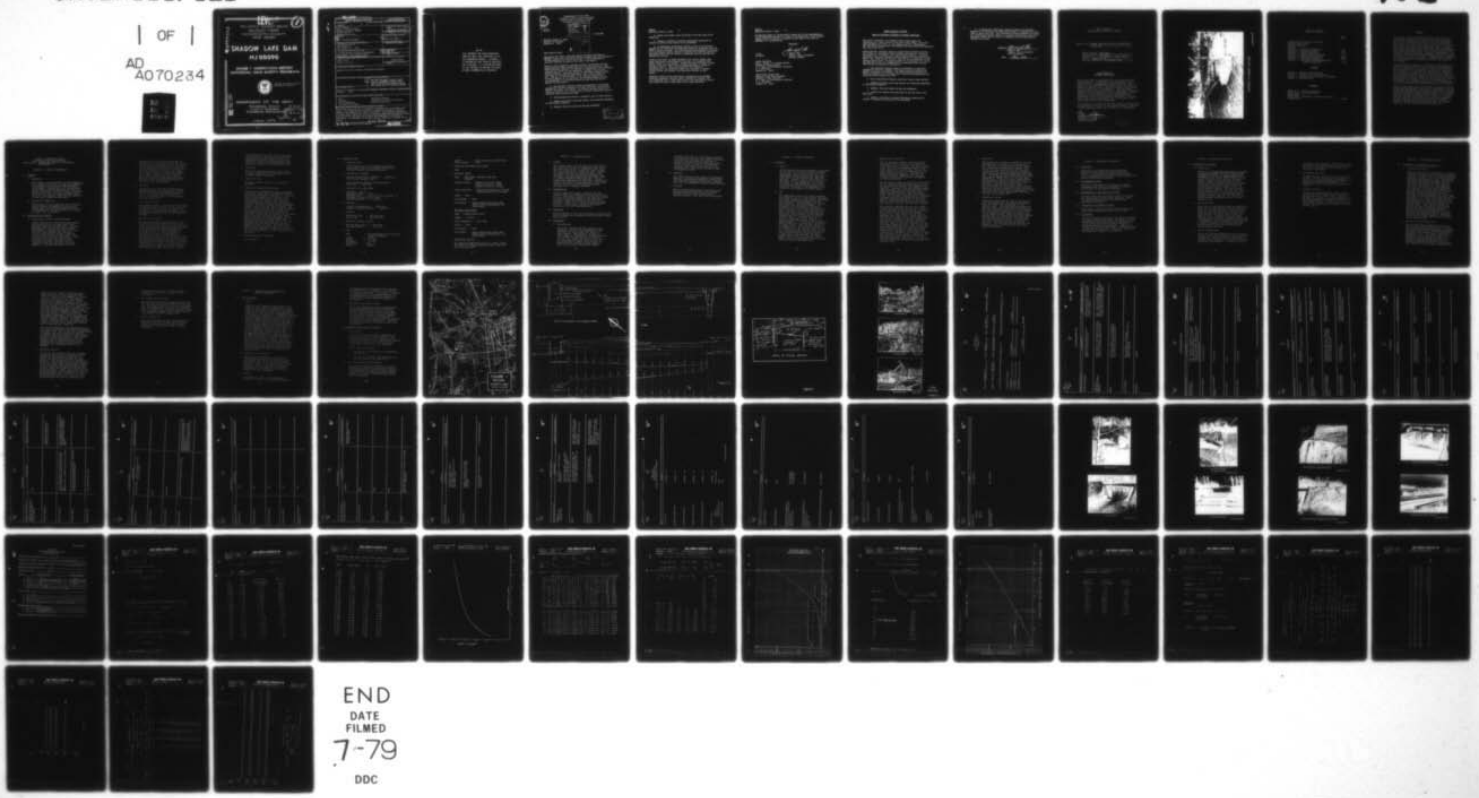

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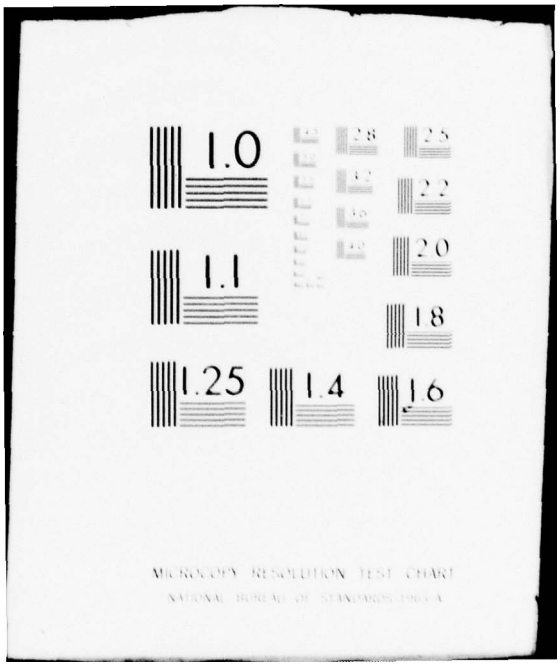
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ATLANTIC COAST BASIN
QUIGLEY CREEK
MONMOUTH COUNTY
NEW JERSEY

SHADOW LAKE DAM
NJ 00090

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

March, 1979

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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National Dam Safety Program
Shadow Lake Dam
Monmouth County, N.J.

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East Orange, N.J. 07019
410 891

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18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

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Dams
Spillways
Visual Inspection
Nut Swamp Road Bridges
Structural analysis
National Dam Inspection Act report
Shadow Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
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PHILADELPHIA, PENNSYLVANIA 19106

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11 JUN 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Shadow Lake Dam in Monmouth County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Shadow Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition. The dam's spillway is considered inadequate since 28 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is the 100-year design Flood). To insure adequacy of the structure, the following remedial actions are recommended to be undertaken within one year from the date of approval of this report:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Patch deteriorated concrete, especially crest of main spillway.

c. Regrade and protect with slope paving, the downstream embankment at the spillway wingwalls.

d. Regrade, level and reseed the main dam embankment.

e. Install new roadway curbs and drains on the west side of Nut Swamp Road.

f. Develop a checklist of periodic maintenance inspections so records of conditions and repairs can be maintained.

g. An engineering investigation should be made of the hydraulic capacity of the downstream Nut Swamp Road bridges in cooperation with the owner of these structures. This investigation should determine the necessity of developing remedial measures to increase the hydraulic capacity of the timber trestle and box culvert to adequately pass the spillway discharges from the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Howard of the Third District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

SHADOW LAKE DAM (NJ00090)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 14 December 1978 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Shadow Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition. The dam's spillway is considered inadequate since 28 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is the 100-year design Flood). To insure adequacy of the structure, the following remedial actions are recommended to be undertaken within one year from the date of approval of this report:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Patch deteriorated concrete, especially crest of main spillway.

c. Regrade and protect with slope paving, the downstream embankment at the spillway wingwalls.

d. Regrade, level and reseed the main dam embankment.

e. Install new roadway curbs and drains on the west side of Nut Swamp Road.

f. Develop a checklist of periodic maintenance inspections so records of conditions and repairs can be maintained.

g. An engineering investigation should be made of the hydraulic capacity of the downstream Nut Swamp Road bridges in cooperation with the owner of these structures. This investigation should determine the necessity of developing remedial measures to increase the hydraulic capacity of the timber trestle and box culvert to adequately pass the spillway discharges from the dam.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 11 June 1979

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Shadow Lake Dam Fed ID# NJ 00090 and NJ ID# 350

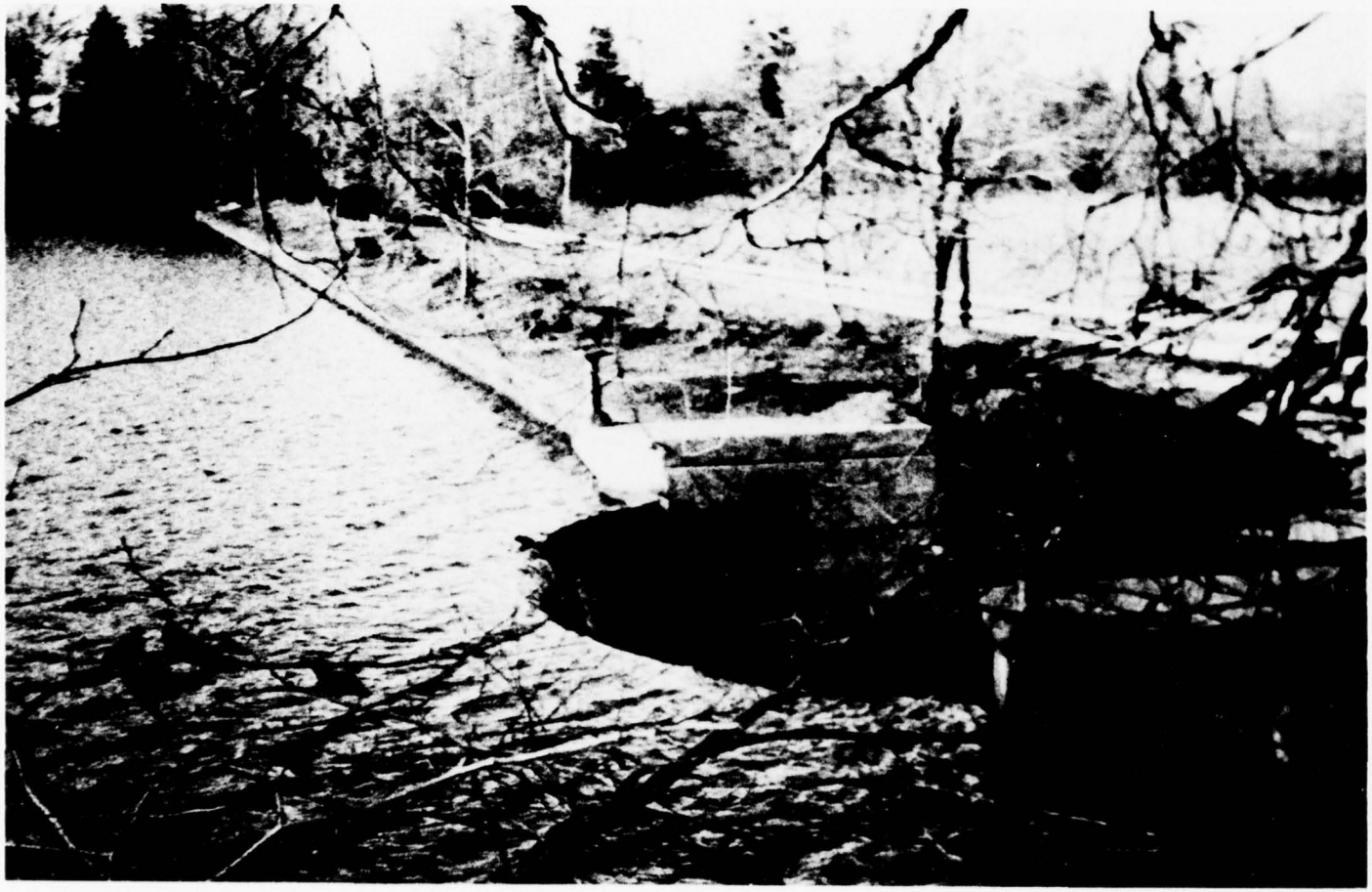
State Located New Jersey
County Located Monmouth
Coordinates Lat. 4021.2 - Long. 7405.2
Stream Quigley Creek
Date of Inspection 14 December 1978

ASSESSMENT OF GENERAL CONDITIONS

Shadow Lake Dam is assessed to be in an overall good condition and is recommended to be downgraded from a high hazard to a significant hazard category. Overtopping of the dam would not substantially increase the danger of loss of life or property damage as the downstream flood plain is uninhabited. No detrimental findings were uncovered to render a hazardous assessment. Remedial actions recommended to be undertaken in the future are 1) regrade and protect the downstream embankment areas at the spillway wingwalls, 2) protect these areas with slope paving and, 3) regrade, level and reseed the main dam embankment.

This dam has an inadequate spillway capacity, being able to accommodate only 27% of the 100-year design flood and further hydraulic/hydrologic studies are recommended.

F. Keith Jolls P.E.
Project Manager



OVERVIEW OF SHADOW LAKE DAM

December 1978

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: SHADOW LAKE DAM FED ID NJ #00090, NJ ID #350

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of Shadow Lake Dam and appurtenant structures, and determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Shadow Lake Dam is a 600' long earth embankment structure with a timber sheet pile bulkhead along its upstream face. Concrete spillways are located near each abutment. The primary, or south, spillway is 40 feet from the right abutment and contains a 45 foot long, notched concrete circular arch weir with two 24" outlet pipes. The elevation of the 23-foot long notch is +9.5, 0.5 feet lower than the crest of the auxiliary, or north, spillway which is located 90 feet from the left, or north, abutment. The north spillway is 20 feet

wide with 10 foot concrete wingwalls on either side at elevation 12.75. The earth portion of the dam contains an interlocking steel sheeting cutoff wall along the axis of the dam which extends up to elevation +9. The steel sheeting is tied to the timber piles which support the upstream bulkhead, by 1" galv. tierods on ten foot centers. Both spillways discharge thru channels which are bridged by Nut Swamp Road which parallels and is immediately adjacent to the toe of the dam backslope.

b. Location

Shadow Lake Dam is located in Middletown, Monmouth County, New Jersey and is built across Quigley Creek immediately upstream from its confluence with the Navesink River. The dam is west of and contiguous with Nut Swamp Road.

c. Size Classification

The maximum height of the dam is 16 feet with a maximum storage capacity of 706 acre-feet. Accordingly, the dam is in the small size category as defined by the criteria in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification

The dam was originally classified as high hazard by governing authorities but as a result of this inspection, it is recommended to be downgraded to significant hazard. The spillways discharge under Nut Swamp Road directly into broad tidal marshlands of the Navesink River. All downstream residences are situated well above the maximum flood, most of which would be assimilated by the marshlands. Historically, the downstream area has demonstrated its ability to absorb major floods. The dam last failed in 1938 and as a result a section of Nut Swamp Road was washed out at that time. The only other noticeable affect was a slight

rise in the level of the river at the downstream marinas. However, as reflected in the above downgraded classification, Nut Swamp Road is quite heavily travelled and provides a rather vital link betweeen the towns and villages to the north and south.

e. Ownership

The dam is owned by Monmouth County Board of Chosen Freeholders, 1 Layfayette Place, Freehold, New Jersey 07728.

f. Purpose of Dam

The dam is used solely for recreational purposes.

g. Design and Construction History

Construction of Shadow Lake Dam, originally called Nut Swamp Dam, was completed in 1931. The original structure consisted of a 600 foot long earth embankment containing a steel sheet piling cutoff wall. Discharge was accommodated by a semi-circular concrete arch spillway located near the south end of the dam. In 1934, a breach in the embankment caused a parting of the sheet piling in the center of the structure and a complete washout of the lower portion of the dam and road. This washout was repaired in 1934 and an auxiliary spillway was constructed at the north end of the dam. In August 1937 plans were approved for raising the embankment and for the installation of a timber sheet pile bulkhead along the upstream face of the dam. This work was not performed and the dam washed out again in 1938. The repairs and modifications originally approved in 1937 were finally completed in 1941 and represents the basic configuration of the structure as it now exists.

h. Normal Operating Procedures

See Section 4

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of the Shadow Lake Dam is seven square miles and consists of partially developed gently sloping topography.

b. Discharge at Damsite

Maximum known flood at damsite - 1400± cfs @ El. 13.5± (October 1943)

Total spillway capacity at maximum pool elevation - 1916 cfs

c. Elevation (ft. above MSL)

Top Dam - +13.75
Recreation pool - +9.5
Spillway crest - +10.0 and +9.5 (see para. i)
Streambed at centerline of dam - -2
Maximum tailwater - +3 (tidal)

d. Reservoir

Length of maximum pool - 8000 feet
Length of recreation pool - 7400 feet

e. Storage

Recreation pool - 310 acre-feet
Top of dam - 706 acre-feet

f. Reservoir Surface (acres)

Top dam (Max. pool) - 106 acres
Recreation pool - 83 acres

g. Dam

Type	-	Earth embankment with upstream timber bulkhead
Length	-	600 feet
Height	-	16 feet
Top Width	-	12± feet
Back Slope	-	2:1
Zoning	-	Unknown

Cutoff - Steel sheet pile cutoff wall
Grout curtain - None

h. Diversion and Regulating Tunnel

None

i. Spillway (Main)

Type - Ogee type, concrete arch weir w/notch

Length of weir - Length of 0.5 foot deep notch is 23 feet. Total length of weir is 45 feet.

Crest elevation - Elevation of notch is +9.5 MSL Crest elevation is +10.0 MSL

Gates - None

U/S Channel - None

D/S Channel - Apron constricted under road bridge before discharging into tidal marsh.

Spillway (Auxiliary)

Type - Broad crested weir

Length - 20 feet

Crest elevation - +10.0 MSL

Gates - None

U/S Channel - None

D/S Channel - Apron constricted under road bridge before discharging into tidal marsh.

j. Regulating Outlets

Two manually operated 24-inch C.I. pipe sluices at invert -1.0 MSL discharge directly onto the main spillway apron.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The contract plans for the original construction were approved for the Nut Swamp Book dam (as it was initially called) in 1929 but copies could not be located by the inspection team. Further, the repair work done in 1934 and 1938 is not recorded. The only design data available were the contract plans prepared in 1940 by Mr. Otis R. Seaman, Monmouth County Engineer, for the repair work undertaken at that time. These plans indicate the overall configuration of the structure but nothing is known regarding design assumptions or allowable stresses.

2.2 CONSTRUCTION

Various inspections made in 1940-41 and 1944 indicate that the reconstruction work was carried out in a workmanlike fashion. The new fill placed in 1941 was well-compacted and no leaks were observed. Nothing is known of the earlier construction except that it suffered three washouts by 1938. Proctor Bros. General Contractors carried out the 1941 reconstruction.

2.3 OPERATION

The dam appears to have been operating satisfactorily from an engineering standpoint since the most recent modification.

2.4 EVALUATION

a. Availability

Sufficient engineering data regarding the makeup or zoning of the embankment is not available to fully assess the design of this element. Additionally, nothing is known about the foundations of each spillway, i.e. whether or not they are founded on piling. The underlying soils in this area are comprised of recent alluvium that is mixed with and overlying swamp deposits. The silt and sand alluvium are highly

variable with some clay and organic material found near the surface. The internal drainage is generally good. Depth to bedrock is generally greater than 100 feet. No recent boring data was located in the immediate vicinity, but from a brief survey of the immediate area, most heavy structural work is founded on piles.

b. Adequacy

The 1940 contract plans prepared by Monmouth County is considered adequate to assess this dam under the purview of the Phase I inspection and the recommended hazard classification.

c. Validity

Based on field observations and discussions with engineering personnel of the County Engineer's office, the existing data obtained appears valid and is not challenged.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspections were conducted on December 10, 14 and 30, 1978 under adverse weather conditions. The lake level did not vary appreciably during this period, with only a few inches of flow passing over the main spillway. However, due to the turbidity of the water and the presence of ice in the reservoir, it was impossible to ascertain any conditions below the reservoir level regarding siltation or the underwater condition of the bulkhead or sluice gates.

b. Dam

The embankment portion and timber bulkhead were found to be in a satisfactory condition and stable except for deep erosion which has developed behind both wingwalls of the main spillway. The backslopes are covered with grass and occasional bushes. The alignment of the bulkhead is slightly distorted but is in overall good condition. Minor sections of the timber whalers are rotted but this could be easily repaired. There was little evidence of any seepage, although much of the backslope area was frozen. Water was flowing into the auxiliary spillway through a CMP in the north wingwall. It could not be determined whether this was a cut-off pipe outlet or a roadway drain. From earlier records, it is doubtful that any cut-off drains were ever installed. The sloughed areas at the toe of the backslopes are of minor concern and could possibly be caused by clogged roadway drains and vehicular splashing rather than a result of seepage. Water appears to have accumulated in several low areas on the west pavement edge.

c. Appurtenant Structures

The two spillways exhibit some weathering reflecting their age but are in basically sound structural condition. The main circular crest has a 23-foot depressed notch in the center portion of the overflow lip and the sides, which are about 6 inches higher, are badly spalled and cracked. However, the overall structure appears in an integral condition with no differential settlement or tilting observed.

The 24" sluice gates are located on each side of the spillway and discharge directly onto the circular sill below. They appear to be operable. Discharge from the spillway apron flows directly into the Navesink River tidal marshland immediately to the east thru a timber trestle structure under Nut Swamp Road. This bridge is hydraulically inadequate to handle the spillway discharge and is of dubious structural strength. A 20" water main is carried along the west fascia which additionally restricts the hydraulic opening.

The auxiliary spillway is also in a sound structural condition with only minor superficial cracking in the apron slab. The wingwalls which extend east to the roadway culvert are in good condition and have 4" weepholes near their base. These walls tie into the box culvert at roughly roadway profile grade. Discharge from the auxiliary spillway flows across a broad crested weir directly into an old 5'x9' concrete box culvert under Swamp Nut Road. This culvert has experienced some type of foundation failure and is displaced laterally several inches downstream. Although it shows only minor cracking, the northwest and southeast corners have settled several inches. Similar to the main spillway, heavy discharges over the auxiliary spillway, especially if occuring during a high tide, would quite possibly flow over the road.

d. Reservoir

The Shadow Lake reservoir extends to the west approximately 1.4 miles to a railroad and U.S. Military road immediately to the east of Mile 108 on the Garden State Parkway. Much of the frontage is bounded by the military reservation but there are private residential areas along both shores immediately above the dam. The banks are quite steep with all houses upstream and downstream 20 to 40 feet above normal pool. There is no major debris along the shorelines, which are heavily wooded in a majority of the reaches of the lake. The shoreline just above the dam is quite heavily scoured at the waterline and numerous trees are inclined towards the lake indicating that some long-term creep is taking place. Both Quigley Creek and Nut Swamp Brook feed into the lake at its upper end.

e. Downstream Channel

Immediately below the dam and to the east of Great Nut Swamp Road, the stream discharges into the broad tidal marshlands of the Navesink River. All surrounding residential areas are well above high tide elevation and the only low-lying facilities in the immediate area are marina facilities and the east end of the Hubbard Bridge (where it passes under the New York and Long Branch railroad trestle). This is about 0.5 mile below the study dam and would experience little, if any, effect of a rise in water elevation should the dam fail. The railroad trestle crossing the Navesink River is more than 20 feet above normal high water.

SECOND 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were discussed with personnel of the Monmouth County Engineers office. Procedures are conducted principally on an as-needed basis and there are no established formal operational procedures.

4.2 MAINTENANCE OF DAM

The dam is periodically inspected and repairs undertaken when funds are available. There is no evidence of any recent maintenance.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operating facilities in use are the two 24" sluice gates at the south spillway. These are periodically inspected by County Road Department personnel.

4.4 DESCRIPTION OF WARNING SYSTEM

None exists except for monitoring by County and local police personnel during major storms.

4.5 EVALUATION

Since the drawdown facilities for Shadow Lake Dam are hydraulically restricted, especially if heavy flooding occurs during periods of abnormal high tide, little exists that could be evaluated regarding operational procedures. However, in view of the extent of the County's responsibility and the hazard condition of this dam, operational procedures are deemed to be adequate.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 ELEVATION OF FEATURES

a. Design Data

Based on the Recommended Guidelines for Safety Inspection of Dams, the dam at Shadow Lake is small in size and of significant hazard. Accordingly the design flood selected by the inspection team is the 100-year frequency event. Inflow to the reservoir for the 100-year SDF was computed utilizing precipitation data from Technical Publication 40 and Hydrometeorological Report 35 by the HEC-1 computer program. This gave a peak inflow to the reservoir of 9,029 cfs. When routed through the reservoir the peak was reduced to 7,156 cfs. The spillway has a maximum discharge capacity of 1,916 cfs and therefore can accommodate only 27% of the design flood.

b. Experience Data

There are no streamflow records available for this site, as the only monitoring which takes place is for water quality. Early records indicate that the dam has been washed out at least twice in the past, once in 1934 and once in 1938. In October 1943 the lower portion of the auxiliary spillway wingwall was overtopped by 6" of water which would indicate a flood with a peak of approximately 1400 cfs. A partial reason for the earlier breaching was reported to have been excessive wave action against the dam.

c. Visual Observations

Since the 1941 reconstruction, the dam appears to have functioned adequately from a hydraulic standpoint. However, with the exception of the 1943 event, nothing is known regarding any subsequent overtoppings. Certainly, a major

overtopping flow would be concentrated at the low spots in the embankment crest to the left of the main spillway and would immediately flood the road below.

d. Overtopping Potential

Records indicate the dam was last overtopped in 1943. As the spillway can accommodate only 27% of the design flood the potential for overtopping remains considerable. The design flood would overtop the dam by about 2 feet.

e. Drawdown Potential

It would take approximately 3 days to draw Shadow Lake down to the invert elevation of the two 24" sluice gates. This assumes no abnormal high tides or upstream inflow during the drawdown period. Further, some water would remain behind the dam as certain areas between the spillways are reported to be over 13 feet deep.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based on the review of the design information available and the visual inspections, Shadow Lake Dam is deemed to be in a sound structural condition as long as it is not overtopped by extremely high hydraulic heads. The inspection team was mainly concerned with the foundation aspects of the steel sheeting core wall (see Figure 3). The breaching and failure of the dam in 1938 destroyed over 100 feet of the existing sheeting in a zone beginning 130 feet north of the main spillway. This was replaced with new sheeting but the zones adjacent to the break utilized the older sheeting, which was tilted downstream 1 to 3 feet at the top cut-off. Practically all of the dam embankment below the sheetline was completely scoured out to depths between 15 and 25 feet below the present crest. The juncture between the new and old work was drawn together with bolts with come-a-longs and the older sheeting was so out-of-plumb that it could not be interlocked with the new sections and had to be welded together. Following this, the new timber bulkhead was installed on the upstream face.

b. Design and Construction Data

The original design computations for overturning and sliding stability for the core wall construction were unavailable. However, from the examination of the 1940 reconstruction plans, it is evident that continued stability relies, to a great degree, on the permanence of the embankment back slope material below the steel core wall. In view of the predominating sand and silt foundation material prevalent in this area, the resistance of the timber bulkhead piles

against lateral loads is extremely small. These piles are 25 feet long creosoted (12" to 14" butt) round members at 10 feet centers. With the 3 x 10 inch whalers and vertical planking they offer minimal assistance in resisting lateral loads. In effect, the bulkhead stabilizes the upstream face but serves little use as a deadman in laterally bracing the steel corewall (if this were the intended purpose of the tierods). The replaced fill embankment below the corewall was termed a "clayey road gravel, thoroughly compacted" in the 1940 plans but the degree of permeability and compactness remains unknown. However, it appears to be a dense, satisfactory fill and excepting for damage to the top crest (from motor bikes), is in a satisfactory condition.

The concrete spillways are adjudged to be in an equally satisfactory condition commensurate with their age. Due to the lack of differential settlement and major structural cracking, it appears they are founded on timber piling. There is efflorescence noted at the joints between the main spillway crest and the wingwalls and as previously noted, the platform slabs cantilevered out from the wingwalls are completely undercut and exposed.

c. Operating Records

No records are available but the spillways operate satisfactorily and exhibit little structural deterioration except for the top of the ogee lip on the main circular spillway. The downstream toe of embankment which, in effect, forms the westerly shoulder of the Nut Swamp Road travelled way appears to be a continual maintenance problem, with clogged drains and roadway run-off ponding in the low spots. Heavy storm flows over the spillways appear to be continuously damaging both downstream road structures. As previously stated, the 5' x 9' culvert at the north spillway has shifted laterally and

settled several inches, and the approach pavement is cracked as a result of the settlement.

d. Post Construction Changes

The only post construction changes noted since the 1941 reconstruction has been the addition of steel sheeting north of the auxiliary spillway. The embankment in this area is damp but this is thought to be caused by surface run-off from the natural higher terrain above the dam (the wingwall weepholes appear dry).

e. Seismic Stability

This dam is located in Zone 1 and experience indicates that dams in this zone will have adequate stability under dynamic loading conditions if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection procedures stipulated by the Corps of Engineers, the Shadow Lake Dam is adjudged to be in an adequately sound structural condition, although the two spillways are incapable of transmitting the SDF. No detrimental findings were revealed except those recommended to be corrected by the remedial items stipulated below. The embankment stability against severe overtopping remains questionable as the stability of the steel sheeting corewall relies principally on the embankment backslope fill. The present spillway capacity is inadequate and does not meet the requirements of the Recommended Guidelines for Safety Inspection of Dams, being able to accommodate only 27 percent of the design flood as calculated by Corps of Engineers criteria. The SDF would overtop the dam crest by approximately two feet, but it is felt that the dam could sustain this if the remedial measures are correctly undertaken and the crest and backslope surfaces sufficiently stabilized to prevent scour.

b. Adequacy of Information

The information obtained for the Phase I inspection is deemed to be adequate and it is believed that little else is available. Performance data is also believed to be nonexistent. However, in view of the hazard classification and downstream marshland conditions, the information is considered adequate for the assessment.

c. Urgency

A collapse of either of the downstream structures carrying the spillway flow under

Nut Swamp Road could endanger the integrity of the study dam. However, in view of all mitigating conditions, no urgency is attached to implementing further studies and it is recommended that the remedial measures set forth below be taken under advisement in the future.

d. Necessity for Further Study

Due to the downgraded hazard classification recommended herein and the fact that no property damage (except to the dam itself and Nut Swamp Road) is likely in the event of a collapse, further structural studies regarding the dam itself are believed to be unnecessary (this opinion does not include the roadway drainage structures). However, additional hydraulic/hydrologic studies are recommended.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Alternatives

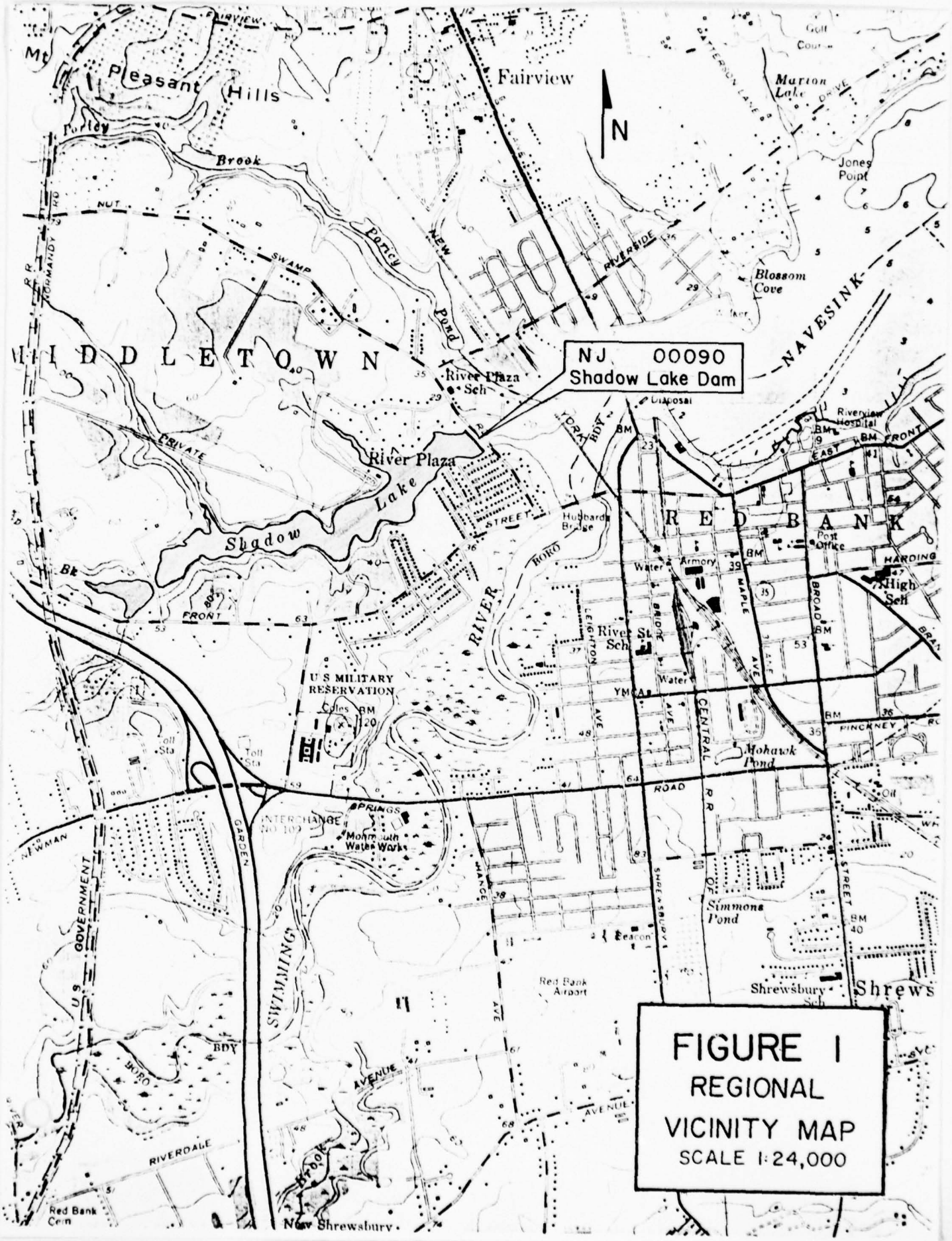
On the basis of the present conditions and structural geometry, improvements to the existing spillways are not warranted. The deteriorated areas of the concrete work should be patched, especially on the top of the curved ogee crest of the main spillway.

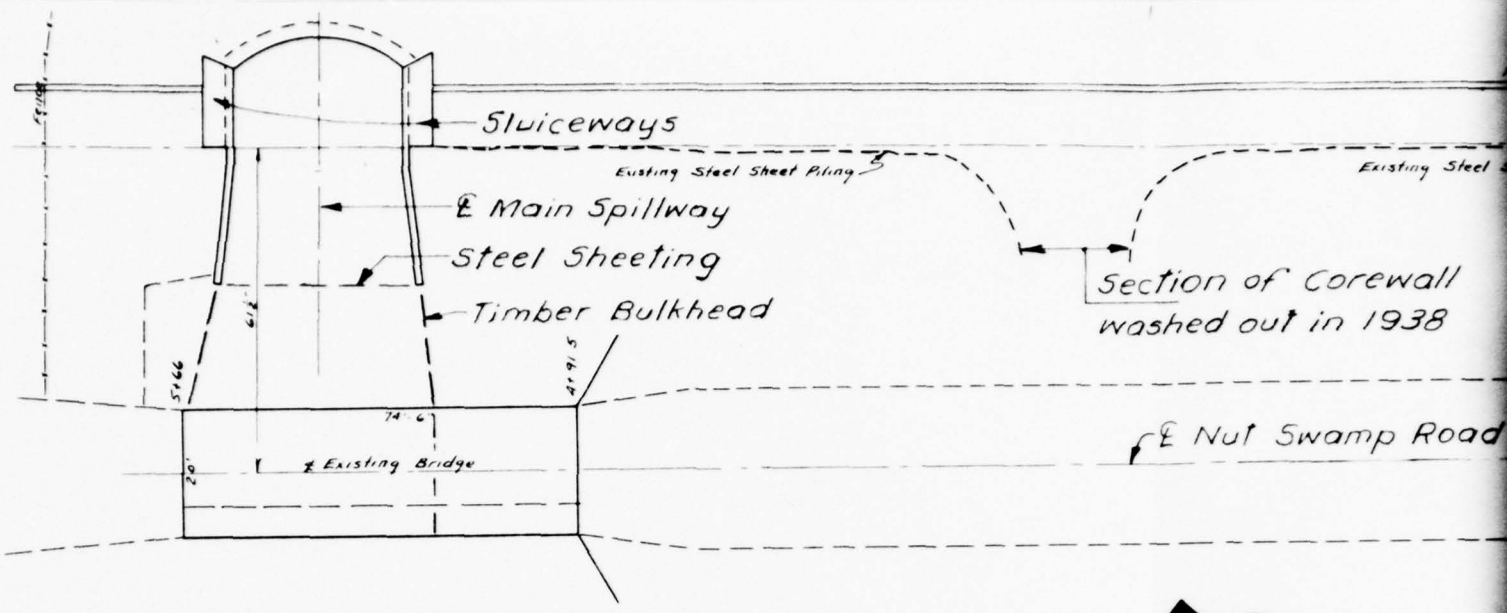
Other remedial measures:

- Regrade top and backslopes of embankment and reseed.
- Install new roadway curbs and drains on the west side of Nut Swamp Road.

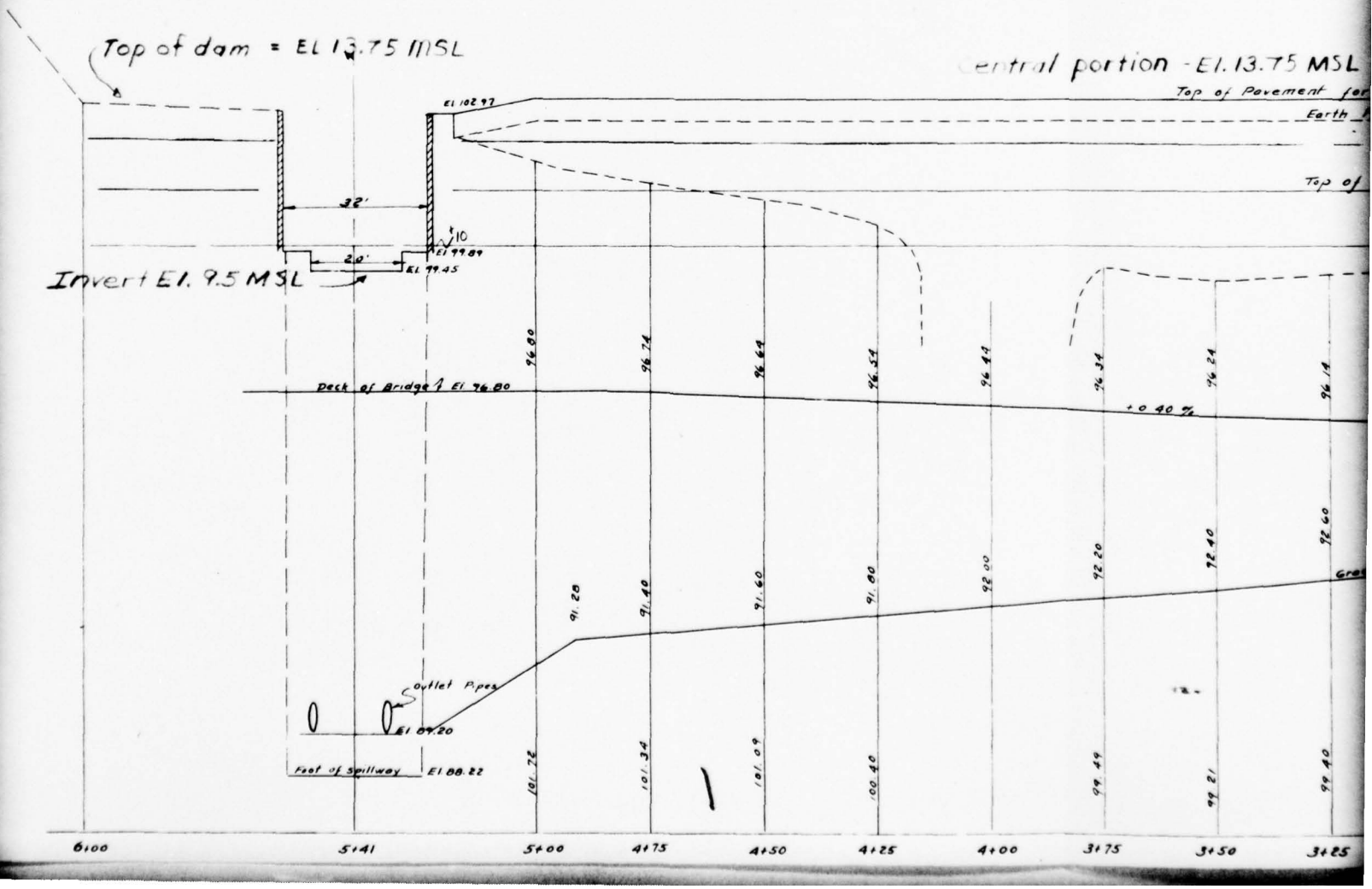
b. O&M Maintenance and Procedures

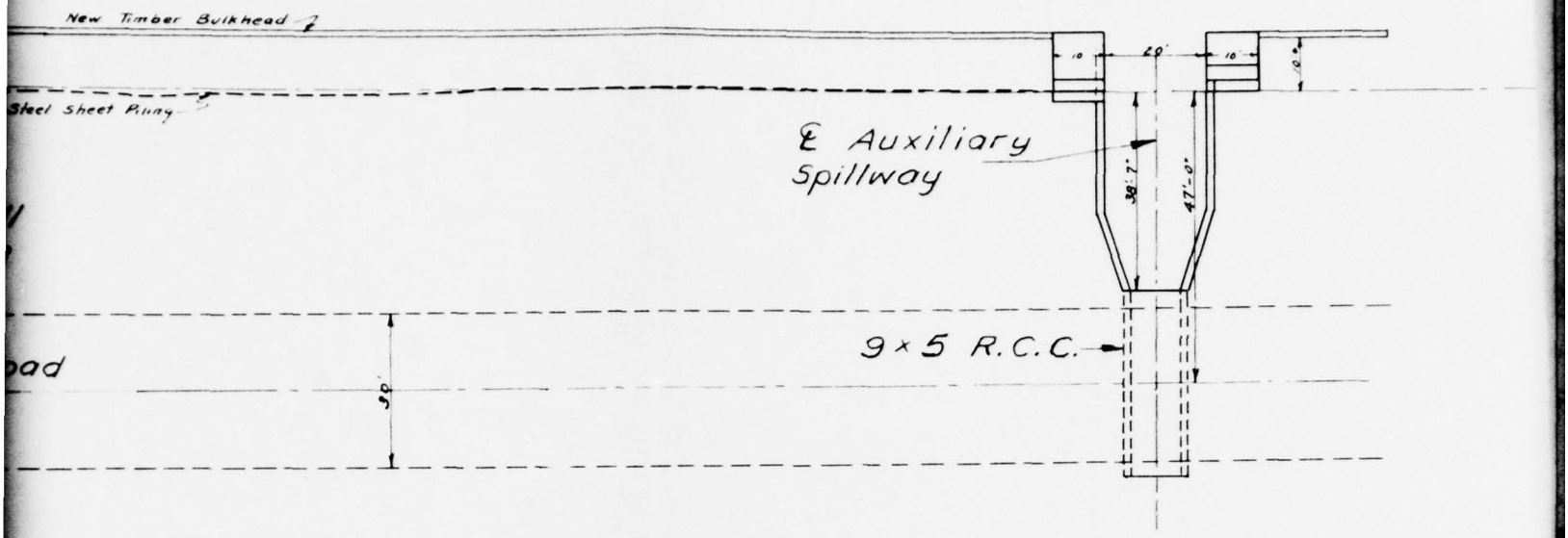
No additional procedures other than those presently in effect are warranted, except it is recommended that Monmouth County develop a checklist of periodic maintenance inspections so records of conditions and repairs can be maintained.


NJ 00090
Shadow Lake Dam
N
Fairview
Mt. Pleasant Hills
Marion Lake
Jones Point
Blossom Cove
NAVESINK
MIDDLETOWN
River Plaza
River Plaza Sch
Shadow Lake
Swamp Brook
Pond
RED BANK
Riverview Hospital
Post Office
Armory
High Sch
River St Sch
Hubbards Bridge
U S MILITARY RESERVATION
Mohawk Pond
Simmons Pond
Red Bank Airport
Shrewsbury Sch
Mohmouth Water Works
Toll Sta
YMCA
Red Bank Cem
New Shrewsbury
Shrews
FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24,000



NOTE: Artificial datum EL. 100 corresponds to 10 MSL.





PLAN

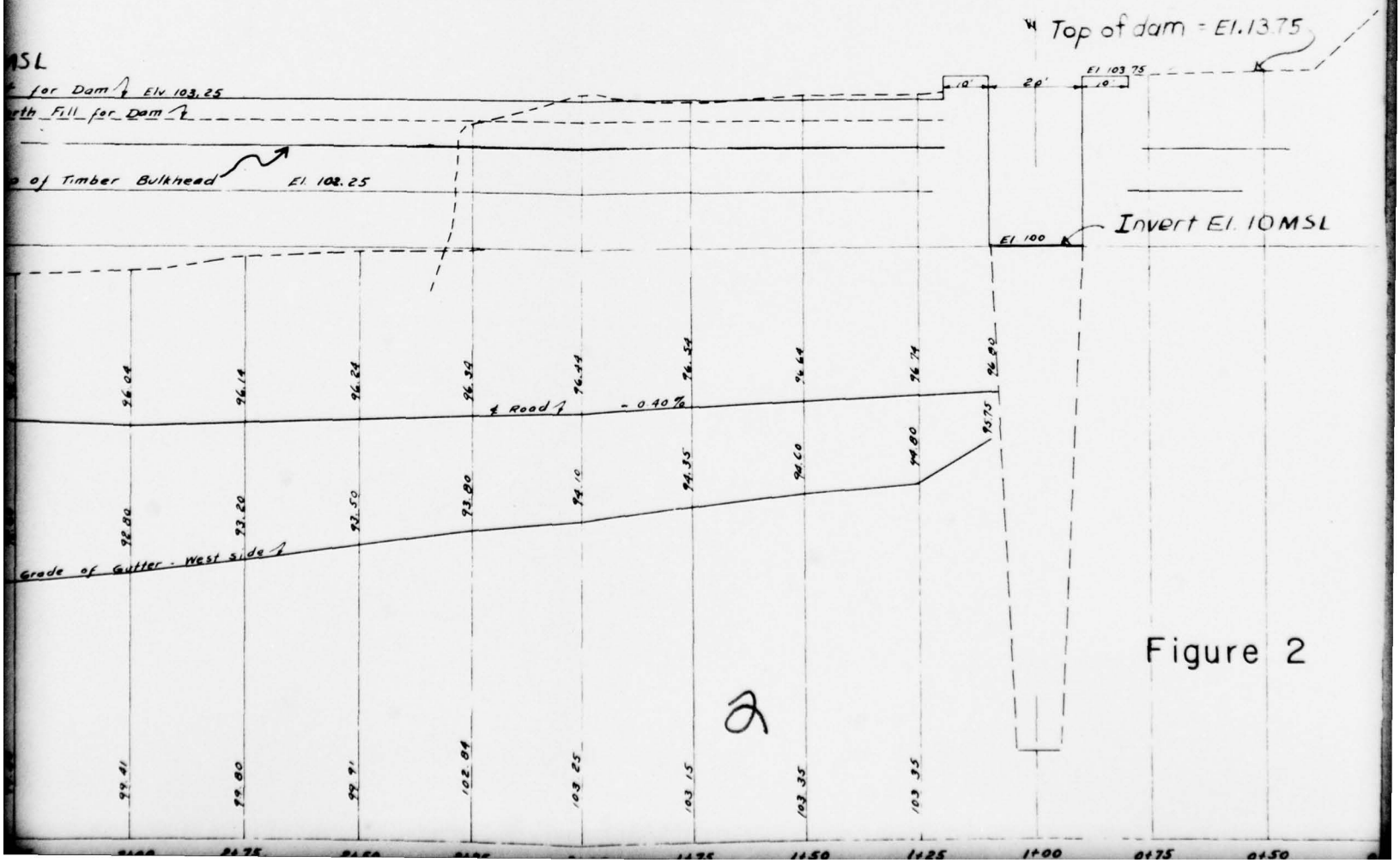
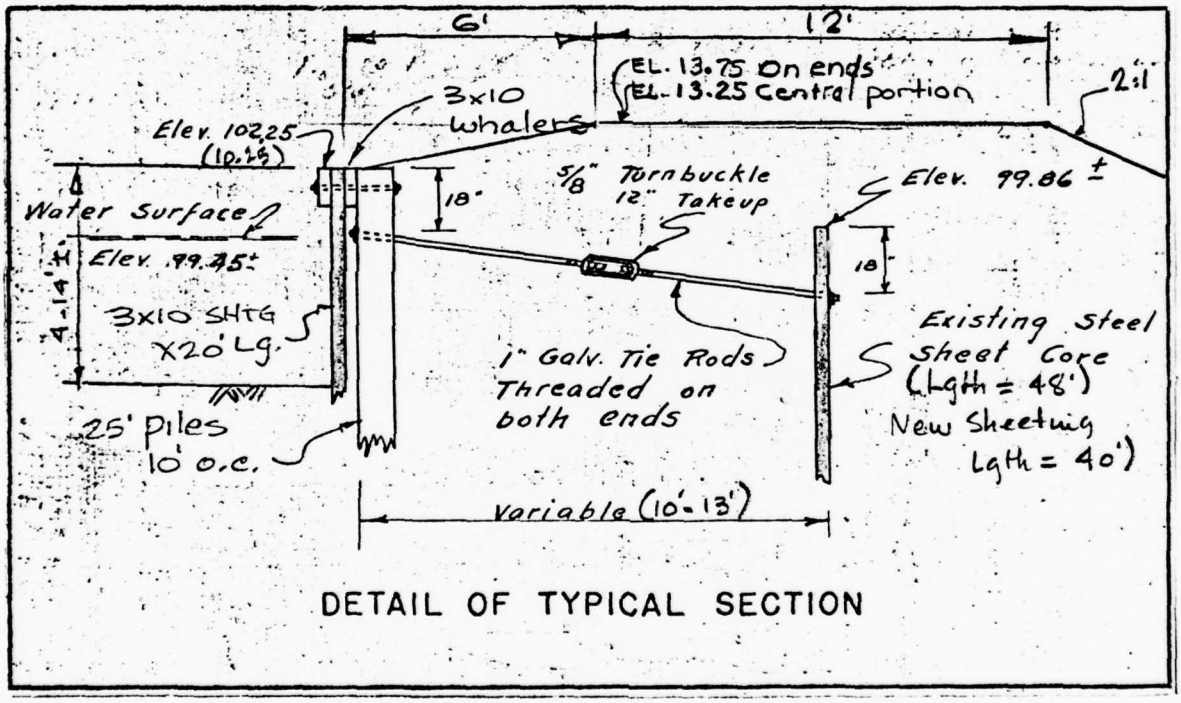


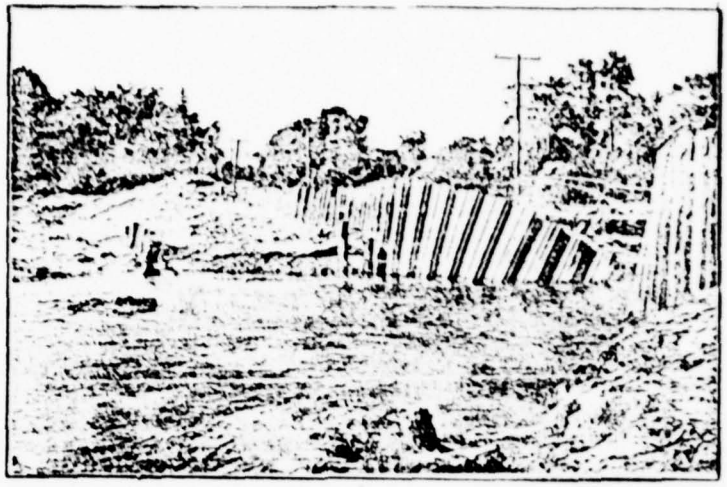
Figure 2

2

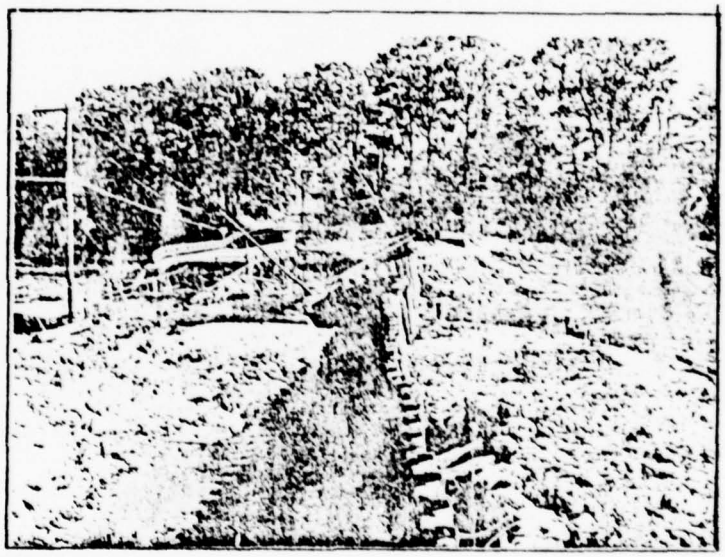


DETAIL OF TYPICAL SECTION

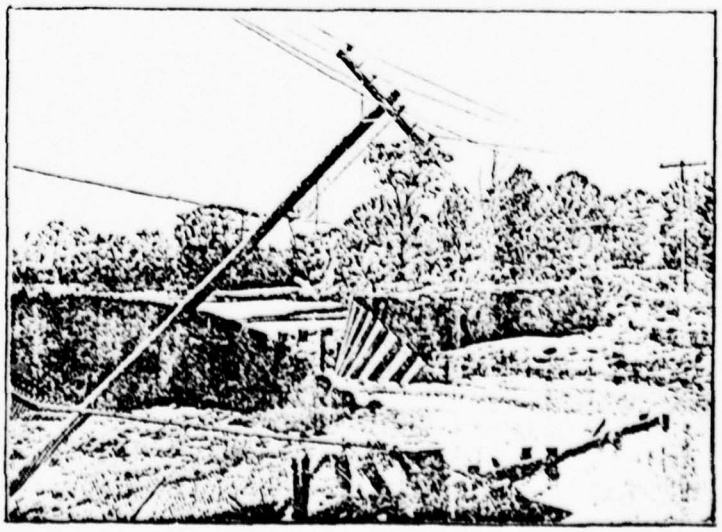
Figure 3



Looking North Sept. 1938



Looking South Sept. 1938



Breached Area Sept. 1938

1938
FAILURE

Figure 4

Check List
Visual Inspection
Phase 1

Name Dam Shadow Lake County Monmouth State New Jersey Coordinators NJDEP

Date(s) Inspection Dec. 10, 14, 30, 1978 Weather Scattered clouds Temperature 20-35°F

Pool Elevation at Time of Inspection + 9.5 M.S.L. Tailwater at Time of Inspection - 2 ± M.S.L.

Inspection Personnel:

T. Chapter T. Giannechini E. Simone

L. Baines K. Jolls

W. Cokelet

L. Baines Recorder

Dam No. 00090

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE	Seepage through cracks at toe of apron of auxiliary spillway.	Timber retaining wall on left side of auxiliary spillway shows early stages or rotting.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Main spillway - satisfactory condition. Auxiliary spillway - some light spalling at area of spillway abutment junction.	Minor. Struct. cracking in app. slab of auxiliary spillway. Auxiliary spillway tied into bridge below top of lower walls level with roadway.
DRAINS	Auxiliary spillway - 20" ø drain and 4" ø weep hole at base of channel on each side of spillway channel wall.	
WATER PASSAGES	Main spillway - satisfactory Auxiliary spillway - Channel narrows at apron of spillway.	
FOUNDATION	Unknown	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Main spillway: Deterioration of crest lip. Extensive spalling of upstream face of weir at waterline. Auxiliary spillway: Superficial cracks on spillway as well as some spalling on broad crested weir.	Approximately 2½' section of lip has broken off on main spillway.
STRUCTURAL CRACKING	See previous page	
VERTICAL AND HORIZONTAL ALIGNMENT	Satisfactory	
MONOLITH JOINTS	None	
CONSTRUCTION JOINTS	Satisfactory	Spillway structures old but in fairly good condition.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed. Back slopes - considerable sloughing.	Top elevation varies considerably. Should be regraded level.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	Timber bulkhead alinement satisfactory. (Some minor distortion).
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Slight erosion from crest towards upstream face of dam as well as behind wingwalls (see photo). Some erosion from crest towards highway.	Several trees immediately next to auxiliary spillway.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Major undulation. (Should be regraded).	The dam apparently has stabilized except for superficial rotting from motorbikes and foot travel.
RIPRAP FAILURES	No riprap.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory but very poor condition at sides of main spillway. Some erosion behind abutment.	Should be protected with slope paving.
ANY NOTICEABLE SEEPAGE	None	Embankment frozen at date of last inspection.
STAFF GAGE AND RECORDER	None	
DRAINS	Road drains with (24" ø) auxiliary spillway wingwalls between structures.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A	
INTAKE STRUCTURE		Curved main spillway crest irregular top elevation.
OUTLET STRUCTURE	2-24" ø steel pipes - steam operated sluice gates through both abutments of main spillway. Wingwall slab - undercut (just back of gates).	Road bridge below auxiliary spillway hydraulically inadequate. Road could flood if dam overtopped.
OUTLET CHANNEL	Empties into main spillway channel connecting to roadway bridges downstream.	
EMERGENCY GATE	None except sluice gates.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Main spillway: narrow crested arch ogee weir (see plans)	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	See above	
BRIDGE AND PIERS	Satisfactory but hydraulically restricted.	Bridge below auxiliary spillway has foundation failure at NW corner (settled 4"+). Road bridge below main spillway hydraulically blocked by 24" line.

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	None	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Unknown	Contract plans indicate an arbitrary datum.
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	USGS water quality gage at bridge on Nut Swamp Road (150' downstream).	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Very steep heavily wooded; 1st growth trees. Side slopes of reservoir 20'-30' above water level.	
SEDIMENTATION	Unknown. Appears quite heavy immediately in front of timber bulkheads.	
	Certain uplands areas of reservoir inaccessible.	U.S. Military Reservation.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Main spillway: bridge directly downstream. Auxiliary spillway: high culvert (9' x 5') directly downstream from auxiliary spillway.	
SLOPES	Both spillway channels empty into a wide marsh bounded by steep high slopes approximately 30' high.	Some roadway drainage along east centerline collects in gutter area. Insufficient curb inlets.
APPROXIMATE NO. OF HOMES AND POPULATION	No homes within flood plain. Only downstream structures are marinas.	Railroad bridge immediately downstream 20-25' above H.W. elevation. Bridge on Front Street very low, 25' above H.W. elevation (on tributary).

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

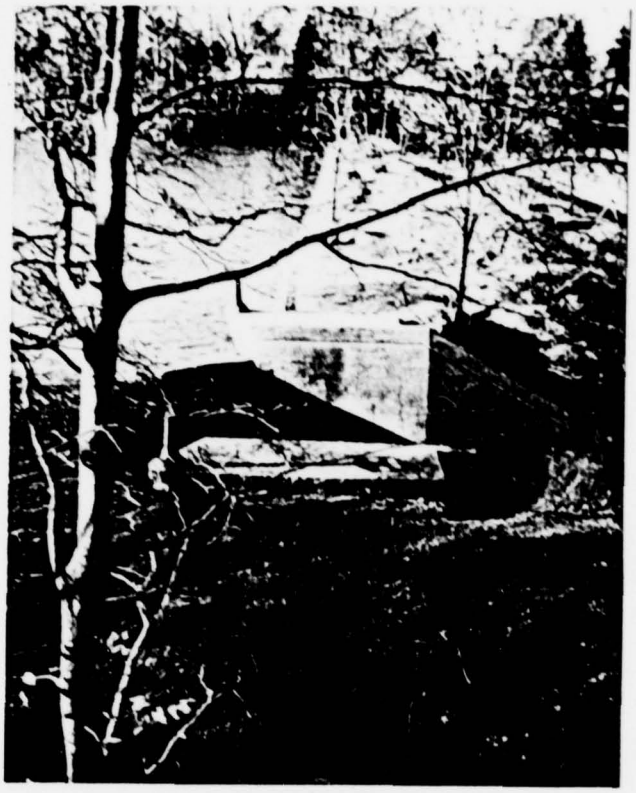
ITEM	REMARKS
PLAN OF DAM	Available (*)
REGIONAL VICINITY MAP	Available (*)
CONSTRUCTION HISTORY	Available (*)
TYPICAL SECTIONS OF DAM	Available (*)
HYDROLOGIC/HYDRAULIC DATA	Available (*)
OUTLETS - PLAN	Available (*)
- DETAILS	Not available
-CONSTRAINTS -DISCHARGE RATINGS	None
RAINFALL/RESERVOIR RECORDS	None

* Available at DEP

ITEM	REMARKS
DESIGN REPORTS	None
GEOLOGY REPORTS	None
DESIGN COMPUTATIONS	
HYDROLOGY & HYDRAULICS	Not available
DAM STABILITY	Not available
SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS	Not available
BORING RECORDS	
LABORATORY	
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	Not available
BORROW SOURCES.	

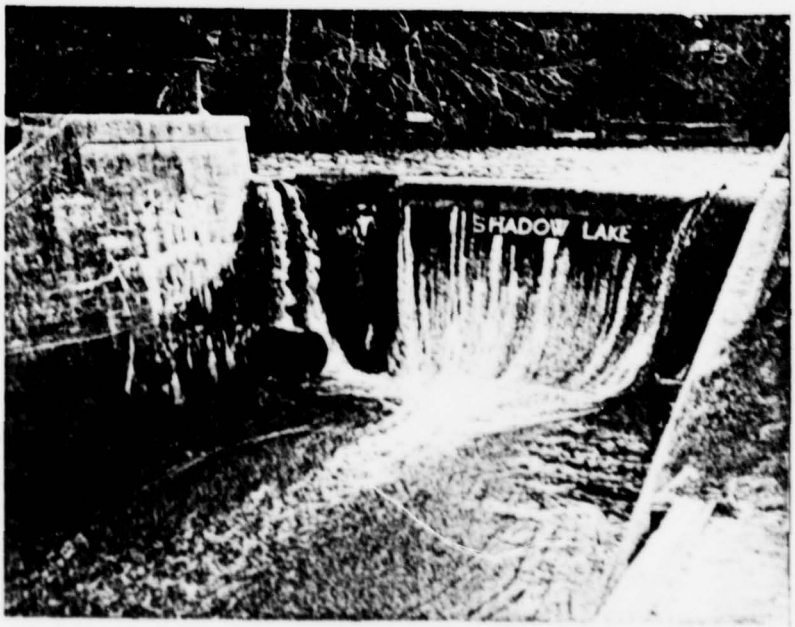
ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Unknown
HIGH POOL RECORDS	Unknown
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Available at DEP
MAINTENANCE OPERATION RECORDS	Not available

ITEM	REMARKS
SPILLWAY PLAN	Not available
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Not available



Main Spillway

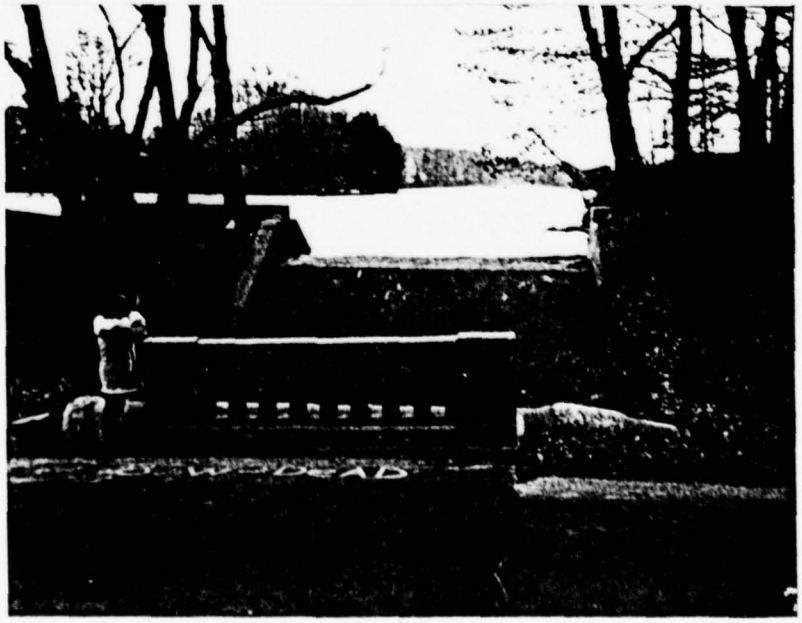
December, 1978



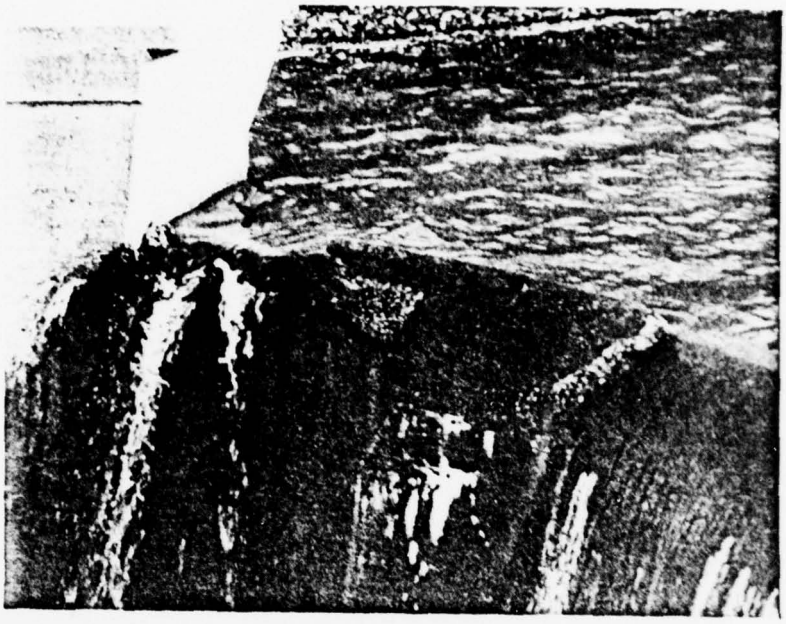
Main Spillway

December, 1978

Auxiliary Spillway
(Looking South)
December, 1978

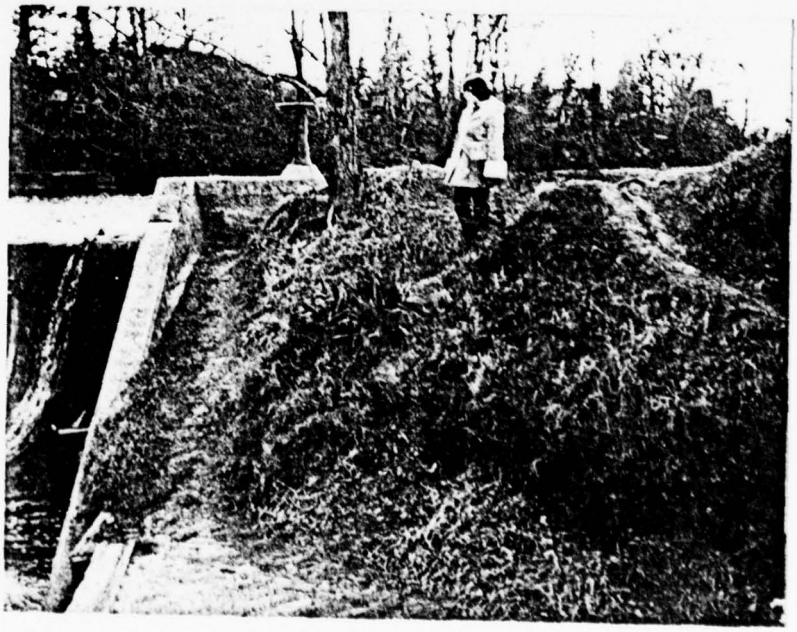


Auxiliary Spillway
December, 1978



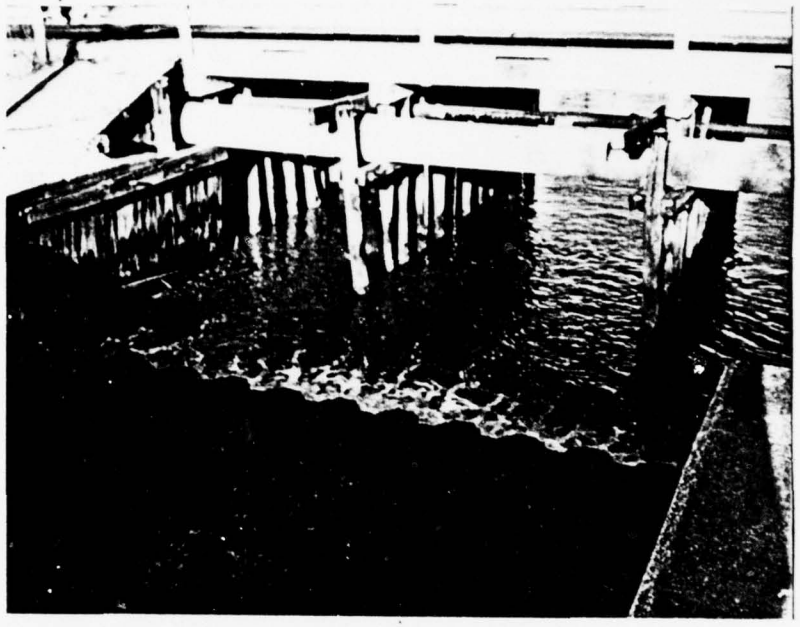
Deterioration of main spillway crest

December 1978



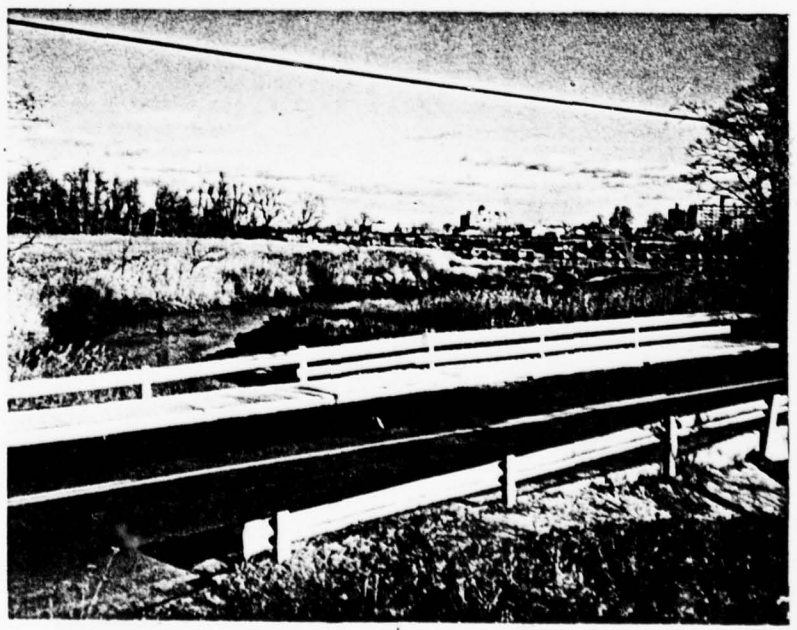
Erosion behind left wingwall of main spillway

December 1978



Bridge below Main Spillway

December, 1978



Bridge below Main Spillway

December, 1978

Dam No. 00090

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 7 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 9.5 (310 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 13.75 (706 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: 13.75

ELEVATION TOP DAM: 13.75

CREST:	South Spillway	North Spillway
a. Elevation	9.5	10.0
b. Type	Ogee-type, notched arch	Broad crested weir
c. Width	2'	10'
d. Length	45'	20'
e. Location Spillover	None	
f. Number and Type of Gates	2-24" dia. C.I. pipe	

OUTLET WORKS:

a. Type None
b. Location
c. Entrance inverts
d. Exit inverts
e. Emergency draindown facilities 2-24" dia. C.I. pipe

HYDROMETEOROLOGICAL GAGES:

a. Type U.S.G.S. Water Quality
b. Location 150' downstream
c. Records No hydraulic records

MAXIMUM NON-DAMAGING DISCHARGE: 1916 + cfs

BY D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO A-1 OF

CHKD. BY DATE SHADOW LAKE DAM INSPECTION PROJECT C 227

SUBJECT Unitgraph Data

Computation of T_c

CALIFORNIA CULVERTS METHOD

$L = 3.4$ miles $H = 190'$

$$T_c = \left(\frac{11.9 \times 3.4^3}{190}\right)^{0.385}$$

$= 1.41$ hours

U.S. NAVY & TEXAS HIGHWAY DEPARTMENT METHOD.

Slope of watercourse $= \frac{190 \times 100}{17952} = 1\%$

Use velocity of 2.0 ft s^{-1}

Gives time $= \frac{17952}{2 \times 3600} = 2.5$ hours

Overland flow negligible

Kirpich's formula (empirical) $T_c = 0.00013 \frac{L^{0.77}}{S^{0.385}}$

$L = 17952'$ $S = 0.011$

$T_c = 1.4$ hours

USE AVERAGE ≈ 1.7 hours

BY DJM DATE 1-79
CHKD. BY _____ DATE _____
SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHADOW LAKE DAM INSPECTION

SHEET NO. A2 OF
PROJECT C227

$$T_p = \frac{0.25}{2} + 0.6 \times 1.7 = 1.15 \text{ hours}$$

$$Q_p = \frac{484 \times 7 \times 1}{1.15} = 2946$$

T	T/T_p	Dimensionless ordinate (DO)	$Q_p \times DO$
0.25	0.22	0.090	265
0.50	0.43	0.323	952
0.75	0.65	0.685	2018
1.00	0.87	0.940	2769
1.25	1.09	0.980	2887
1.50	1.30	0.840	2475
1.75	1.52	0.640	1885
2.00	1.74	0.460	1355
2.25	1.96	0.340	1002
2.50	2.17	0.250	737
2.75	2.39	0.181	533
3.00	2.61	0.128	377
3.25	2.83	0.0940	277
3.50	3.04	0.0719	212
3.75	3.26	0.0547	161
4.00	3.48	0.0370	109
4.25	3.70	0.0288	85
4.50	3.91	0.0210	62
4.75	4.13	0.0156	46
5.00	4.35	0.0117	34

BY ... DATE ...

CHKD. BY ... DATE ...

SUBJECT ...

LOUIS BERGER & ASSOCIATES INC.

SHADOW LAKE DAM INSPECTION

SHEET NO. A3

PROJECT C227

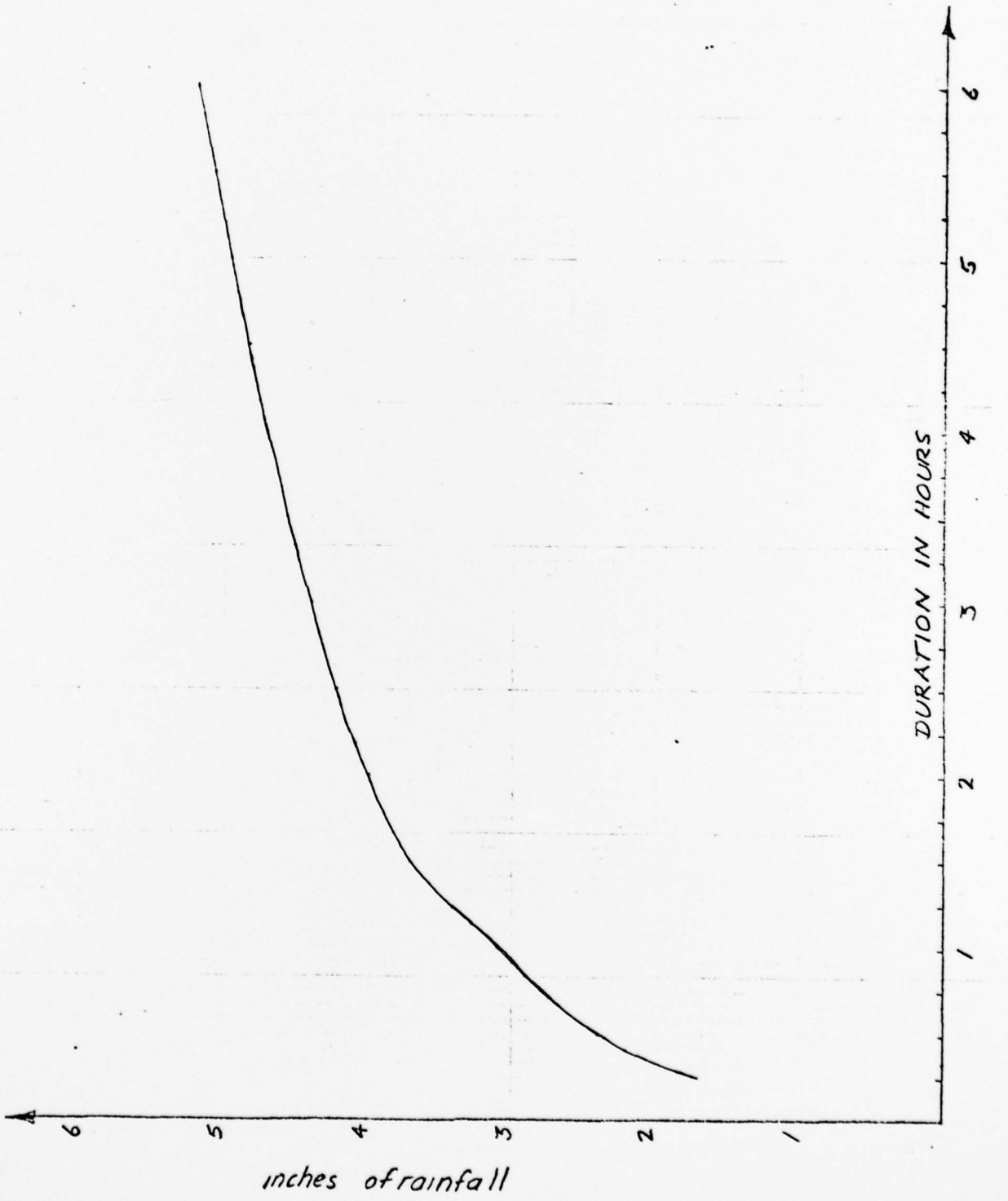
PRECIPITATION DATA FROM T.P. 40 (see depth duration curve overleaf)
& NOAA TECHNICAL MEMORANDUM NWS HYDRO 35

Time	Precipitation	Δ	Rearrange Δ
0.25	1.7	1.7	0.06
0.50	2.4	0.7	0.06
0.75	2.8	0.4	0.06
1.00	3.1	0.3	0.06
1.25	3.4	0.3	0.07
1.50	3.7	0.2	0.07
1.75	3.86	0.16	0.08
2.00	4.00	0.14	0.09
2.25	4.11	0.11	0.09
2.50	4.22	0.11	0.09
2.75	4.31	0.09	0.11
3.00	4.40	0.09	0.11
3.25	4.49	0.09	0.40
3.50	4.57	0.08	0.70
3.75	4.64	0.07	1.70
4.00	4.71	0.07	0.30
4.25	4.78	0.07	0.30
4.50	4.84	0.06	0.20
4.75	4.90	0.06	0.16
5.00	4.96	0.06	0.14
5.25	5.02	0.06	0.07
5.50	5.08	0.06	0.06
5.75	5.14	0.06	0.06
6.00	5.20	0.06	0.06

BY D.J.M DATE 1-79
CHKD. BY ..... DATE .....

SUBJECT T.P. 40 & H.M.R. 35
DEPTH DURATION CURVE

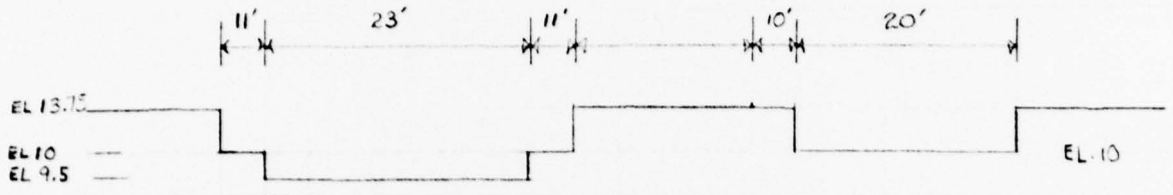
SHEET NO. A3a OF .....
JOB NO. C227



BY LL DATE 1-2-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A4 OF

CHKD. BY DATE SHADOW LAKE DAM PROJECT G-227

SUBJECT SPILLWAY DISCHARGE CAPACITY



EL-1 O O

	Notch: L=25'			WEIR L=22			AUX. SPILLWAY: L=20'			24"ϕ GATES $\Sigma Q = CA\sqrt{2gH}$			
ELEV	H	C	Q	H	C	Q	H	C	Q	H	C	Q	ΣQ
9.5	0	3.2	0	0	3.2	0	0	2.7	0	10.5	.55	90	90
10.	.5	3.2	26	0	3.2	0	0	2.7	0	11	.55	92	118
10.5	1.0	3.2	74	.5	3.2	25	.5	2.7	19	11.5	.55	94	212
11	1.5	3.2	135	1.0	3.2	70	1.0	2.7	54	12.0	.55	96	355
11.5	2.0	3.2	208	1.5	3.2	129	1.5	2.7	99	12.5	.55	98	534
12	2.5	3.2	291	2.0	3.2	199	2.0	2.7	153	13	.55	100	743
12.5	3	3.2	382	2.5	3.2	278	2.5	2.7	213	13.5	.55	102	975
13	3.5	3.2	482	3.0	3.2	366	3.0	2.7	281	14.0	.55	104	1,233
13.5	4	3.2	589	3.5	3.2	461	3.5	2.7	354	14.5	.55	106	1,510
13.75	4.25	3.2	645	3.75	3.2	511	3.75	2.7	392	14.75	.55	106	1,654
14.0	4.5	3.2	703	4.0	3.2	563	4.0	2.7	432	15	.55	107	1,805
14.5	5.0	3.2	823	4.5	3.2	672	4.5	2.7	515	15.5	.55	109	2,119
15.0	5.5	3.2	949	5.0	3.2	787	5.0	2.7	604	16.0	.55	111	2,451
15.5	6.0	3.2	1,082	5.5	3.2	908	5.5	2.7	697	16.5	.55	113	2,800
16.0	6.5	3.2	1,220	6.0	3.2	1,035	6.0	2.7	794	17.0	.55	114	3,163
16.5	7.0	3.2	1,363	6.5	3.2	1,167	6.5	2.7	895	17.5	.55	116	3,541
17.0	7.5	3.2	1,512	7.0	3.2	1,304	7.0	2.7	1000	18	.55	118	3,934
17.5	8.0	3.2	1,665	7.5	3.2	1,446	7.5	2.7	1,109	18.5	.55	119	4,339
18.0	9.5	3.2	2,155	8.0	3.2	1,593	8.0	2.7	1,222	19	.55	121	5,091

BY D.J.M DATE 3-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A5 OF

CHKD. BY ____ DATE ____ SHADOW LAKE DAM INSPECTION PROJECT C227

SUBJECT Spillway Discharge Capacity

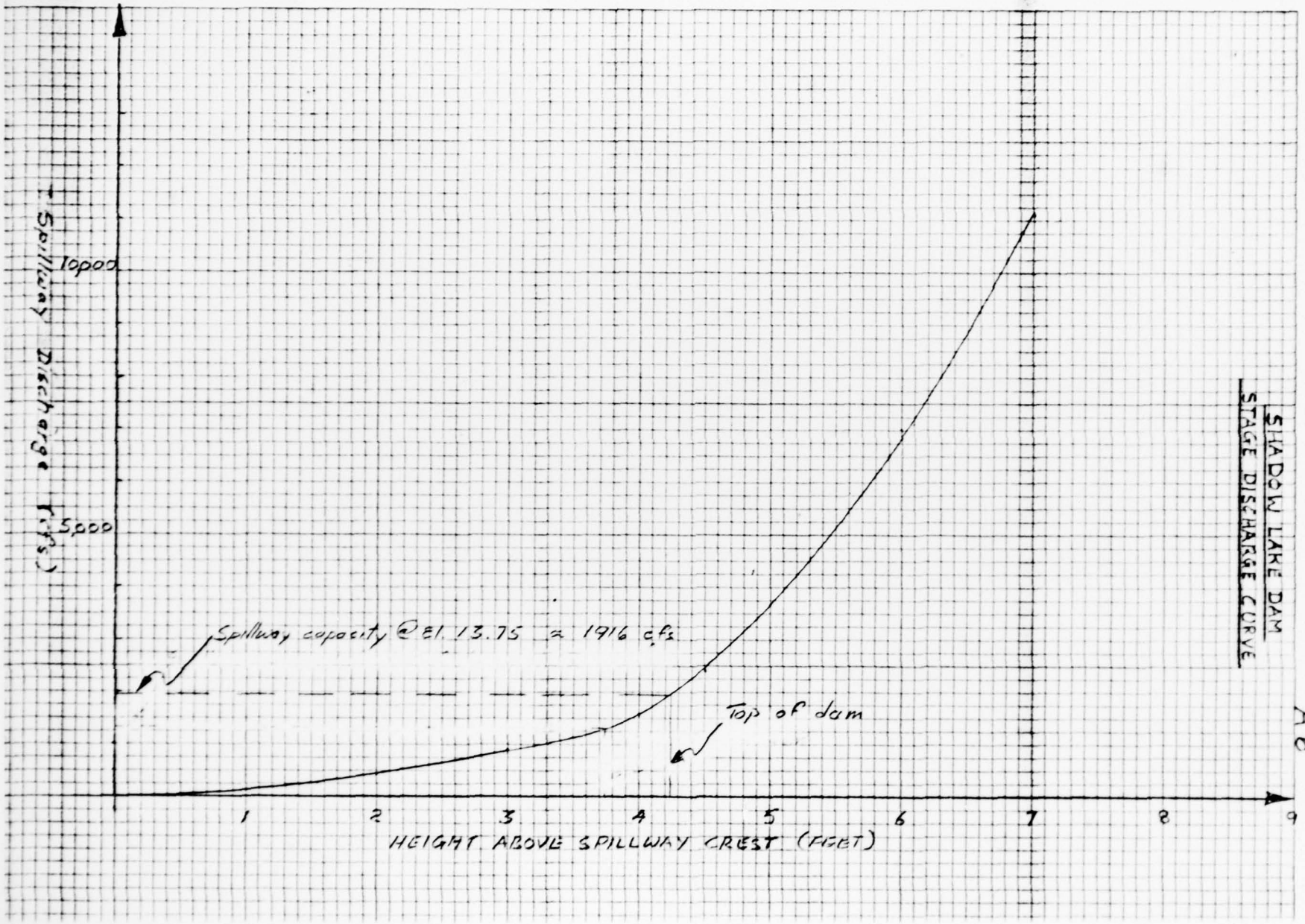
for discharge over dam assume the following :-

length @ Elev. 13.25 ≈ 400 (i)

length @ Elev 13.75 ≈ 135 (ii)

} C = 2.6

flow over (i)			flow over (ii)			Σ Q	
H	C	Q	H	C	Q	H	Q
						0	0
						0.5	26
						1.0	118
						1.5	259
						2.0	436
						2.5	643
						3.0	873
						3.5	1129
0.25	2.6	130	0			4.0	1534
0.50	2.6	368	0			4.25	1916
0.75	2.6	675	0.25	2.6	44	4.5	2417
1.25	2.6	1453	0.75	2.6	228	5.0	3691
1.75	2.6	2408	1.25	2.6	491	5.5	5239
2.25	2.6	3510	1.75	2.6	813	6.0	7010
2.75	2.6	4743	2.25	2.6	1185	6.5	8977
3.25	2.6	6093	2.75	2.6	1601	7.0	11119
3.75	2.6	7552	3.25	2.6	2057	7.5	13425
4.25	2.6	9112	3.75	2.6	2549	8.0	15881
4.75	2.6	10766	4.25	2.6	3075	8.5	18511



SHADOW LAKE DAM
STAGE DISCHARGE CURVE

A6

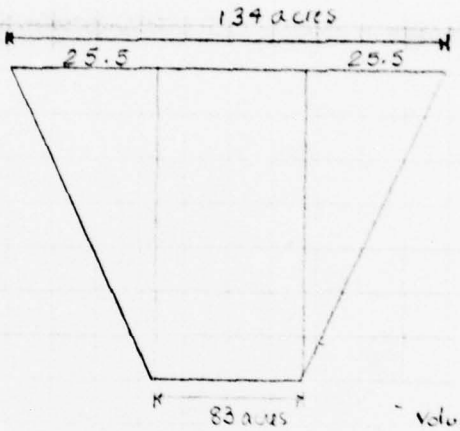
BY LL DATE 12-29-78 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A-7 OF

CHKD. BY DATE SHADOW LAKE DAM PROJECT C-227

SUBJECT SURCHARGE STORAGE

Area - Lake - 83 ACRES (PLANIMETERED)

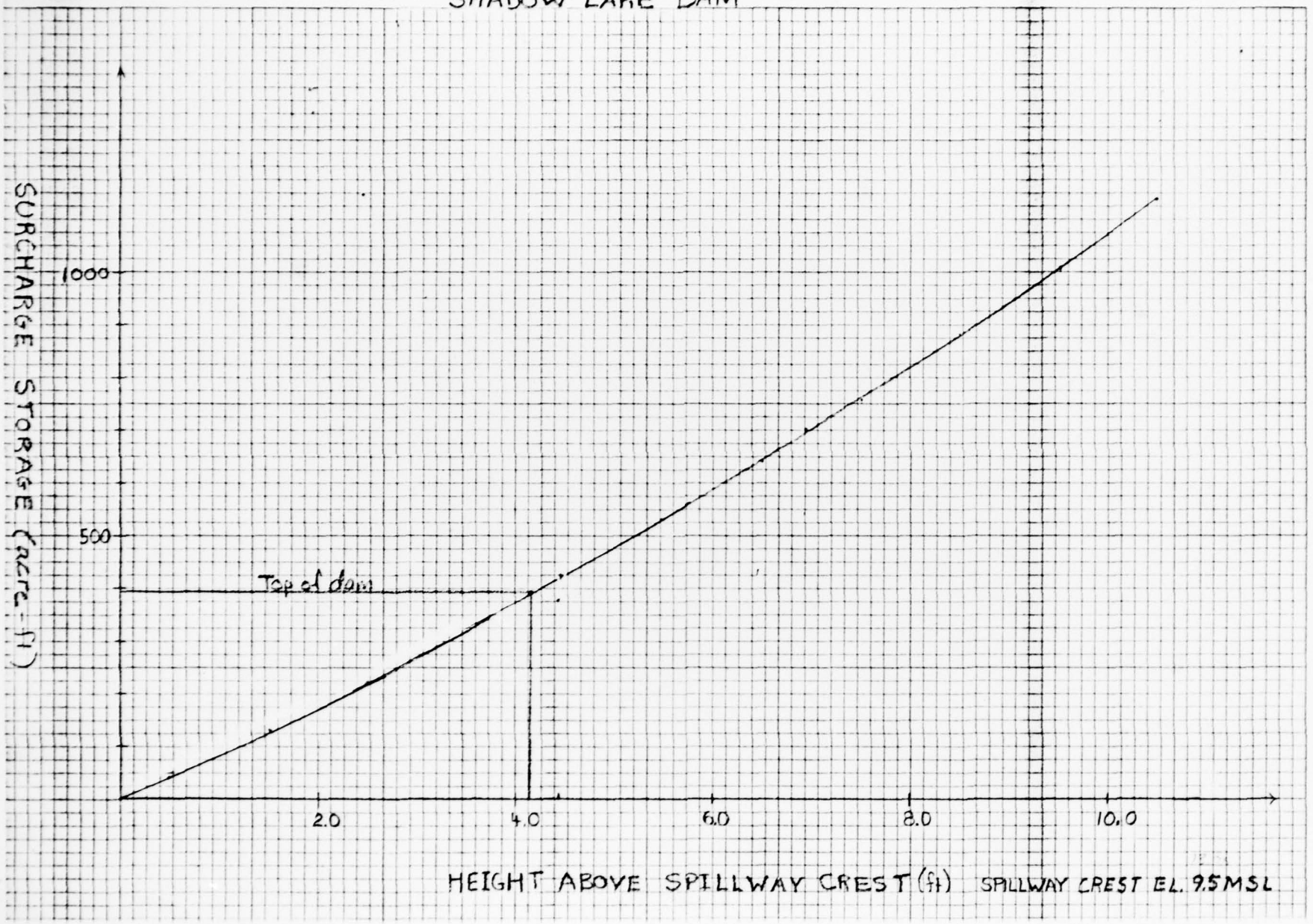
20' Contour - 134 ACRES (PLANIMETERED)



ELEVATION	SURCHARGE STORAGE (ACRE-FT)
9.5	0
10	42.1
11	130
12	222.7
13	320.3
13.75 (Top of dam)	
14	422.7
15	530
16	642.1
17	759.1
18	881.0
19	1007.7
20	1139.3

STORAGE: NORMAL POOL = 310 ACRE-FT ✓

SHADOW LAKE DAM



A-8

BY D J M DATE 1-76 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO A-9 OF

CHKD. BY _____ DATE _____ SHADOW LAKE DAM INSPECTION PROJECT C227

SUBJECT _____

SUMMARY OF STORAGE / DISCHARGE DATA FOR HEC-1 COMPUTER PROGRAM

Elevation (feet)	Storage (acre feet)	Discharge (cfs)
10.5	85	118
11.5	176	436
12.5	271	873
13.5	371	1534
14.0	423	2417
14.5	476	3691
15.0	530	5239
15.5	585	7010
16.5	700	11119
17.5	819	15861

BY D.J.M. DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A-10 of
CHKD. BY ____ DATE ____ SHADOW LAKE DAM INSPECTION PROJECT C227
SUBJECT APPROXIMATE DRAWDOWN CALCULATIONS

Spillway crest El. + 9.5 Invert El. -1.0

$\Delta H = 10.5'$

Approximate Volume = 310 acre feet

$= 13503600\ ft^3$

Drawdown - assume 2 equal stages volume $= 6751800\ ft^3$

Stage 1 Head $\approx 7.9'$

discharge through pipes ≈ 78 cfs

$$\text{time} \approx \frac{6751800}{78 \times 3600} \approx 24 \text{ hours}$$

Stage 2

Head $\approx 2.6'$

discharge through pipes ≈ 45 cfs

$$\text{time} \approx \frac{6751800}{45 \times 3600} \approx 41.7 \text{ hours}$$

$$\Sigma \text{time} = \frac{24 + 41.7}{24} \text{ days, say 3 days}$$

SHADOW LAKE DAM INSPECTIOM NORTH GROUP C227
EXD.J.MULLIGAN
JANUARY 1978

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	0	0

JOPER	NWT
3	0

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR 100-YEAR FREQUENCY EVENT

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
8	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	7.00	0.0	7.00	0.0	0.0	0	0	0

PRECIP DATA

NP	STORM	DAD	DAK
24	0.0	0.0	0.0

PRECIP PATTERN

0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.09	0.09	0.09
0.11	0.11	0.40	0.70	1.70	0.30	0.30	0.20	0.16	0.14
0.07	0.06	0.06	0.06						

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

GIVEN UNIT GRAPH, NUMGG= 20

265.	952.	2010.	2769.	2897.	2475.	1895.	1355.	1002.	737.
533.	377.	277.	212.	161.	109.	85.	62.	46.	34.

UNIT GRAPH TOTALS 18241. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.06	0.00	0.
2	0.06	0.00	0.
3	0.06	0.00	0.
4	0.06	0.00	0.
5	0.07	0.00	0.
6	0.07	0.00	0.
7	0.08	0.00	0.
8	0.09	0.04	10.
9	0.09	0.06	52.

BY DTM DATE
CHKD. BY DATE
SUBJECT SHADOW LAKE DAM

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A-11 OF
PROJECT C227

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHADOW LAKE DAM

SHEET NO. A-12 OF

PROJECT C-227

10	0.09	0.06	152.
11	0.11	0.08	316.
12	0.11	0.08	519.
13	0.40	0.37	809.
14	0.70	0.67	1359.
15	1.70	1.67	2656.
16	0.30	0.27	4771.
17	0.30	0.27	7217.
18	0.20	0.18	8786.
19	0.16	0.13	9029.
20	0.14	0.11	8211.
21	0.07	0.05	6959.
22	0.06	0.04	5700.
23	0.06	0.04	4625.
24	0.06	0.04	3680.
25	0.0	0.0	2883.
26	0.0	0.0	2236.
27	0.0	0.0	1732.
28	0.0	0.0	1325.
29	0.0	0.0	989.
30	0.0	0.0	715.
31	0.0	0.0	529.
32	0.0	0.0	386.
33	0.0	0.0	276.
34	0.0	0.0	186.
35	0.0	0.0	94.
36	0.0	0.0	63.
37	0.0	0.0	40.
38	0.0	0.0	25.
39	0.0	0.0	15.
40	0.0	0.0	8.
41	0.0	0.0	5.
42	0.0	0.0	3.
43	0.0	0.0	1.
44	0.0	0.0	0.
45	0.0	0.0	0.
46	0.0	0.0	0.
47	0.0	0.0	0.
48	0.0	0.0	0.
49	0.0	0.0	0.
50	0.0	0.0	0.
51	0.0	0.0	0.
52	0.0	0.0	0.
53	0.0	0.0	0.
54	0.0	0.0	0.
55	0.0	0.0	0.
56	0.0	0.0	0.
57	0.0	0.0	0.
58	0.0	0.0	0.
59	0.0	0.0	0.
60	0.0	0.0	0.
61	0.0	0.0	0.
62	0.0	0.0	0.
63	0.0	0.0	0.
64	0.0	0.0	0.
65	0.0	0.0	0.
66	0.0	0.0	0.
67	0.0	0.0	0.
68	0.0	0.0	0.
69	0.0	0.0	0.
70	0.0	0.0	0.

LOUIS BERGER & ASSOCIATES INC.

SHADOW LAKE DAM

71	0.0	0.0	0.
72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.
89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
SUM	5.10	4.16	76362.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9029.	3162.	795.	764.	76358.
INCHES		4.20	4.23	4.23	4.23
AC-FT		1569.	1578.	1578.	1578.

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHADOW LAKE

SHEET NO. A-14 OF

PROJECT C 227

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
68	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	85.	271.	371.	423.	476.	530.	585.	700.	819.
OUTFLOW=	0.	118.	873.	1534.	2417.	3691.	5239.	7010.	11119.	15881.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	0.	5.	0.
9	1.	31.	1.
10	3.	102.	4.
11	7.	234.	10.
12	16.	417.	22.
13	29.	664.	40.
14	50.	1084.	70.
15	89.	2008.	136.
16	160.	3713.	424.
17	271.	5994.	872.
18	405.	8001.	2116.
19	517.	8907.	4870.
20	576.	8620.	6708.
21	589.	7585.	7156.
22	576.	6329.	6733.
23	552.	5162.	5949.
24	524.	4152.	5068.
25	496.	3281.	4251.
26	468.	2560.	3506.
27	443.	1984.	2900.
28	420.	1528.	2370.
29	399.	1157.	2008.
30	379.	852.	1663.
31	359.	622.	1456.
32	340.	457.	1328.
33	321.	331.	1201.
34	302.	231.	1077.
35	284.	140.	957.
36	267.	73.	855.

BY R.I.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHADOW LAKE DAM

SHEET NO. A-15 OF

PROJECT C-227

37	251.	52.	791.
38	236.	35.	730.
39	222.	20.	672.
40	208.	12.	619.
41	196.	7.	570.
42	185.	4.	524.
43	175.	2.	482.
44	165.	1.	444.
45	156.	0.	408.
46	148.	0.	375.
47	141.	0.	345.
48	134.	0.	317.
49	128.	0.	292.
50	122.	0.	268.
51	117.	0.	247.
52	112.	0.	227.
53	107.	0.	208.
54	103.	0.	192.
55	99.	0.	176.
56	96.	0.	162.
57	93.	0.	149.
58	90.	0.	137.
59	87.	0.	126.
60	84.	0.	117.
61	82.	0.	114.
62	80.	0.	111.
63	77.	0.	108.
64	75.	0.	105.
65	73.	0.	102.
66	71.	0.	99.
67	69.	0.	96.
68	67.	0.	93.
69	65.	0.	91.
70	63.	0.	88.
71	62.	0.	86.
72	60.	0.	83.
73	58.	0.	81.
74	57.	0.	78.
75	55.	0.	76.
76	53.	0.	74.
77	52.	0.	72.
78	50.	0.	70.
79	49.	0.	68.
80	48.	0.	66.
81	46.	0.	64.
82	45.	0.	62.
83	44.	0.	61.
84	42.	0.	59.
85	41.	0.	57.
86	40.	0.	56.
87	39.	0.	54.
88	38.	0.	53.
89	37.	0.	51.
90	36.	0.	50.
91	35.	0.	48.
92	34.	0.	47.
93	33.	0.	45.
94	32.	0.	44.
95	31.	0.	43.
96	30.	0.	42.
97	29.	0.	41.
98	28.	0.	39.
99	28.	0.	38.
100	27.	0.	37.
SUM			75078.

RUNOFF SUMMARY, AVERAGE FLOW

HYDROGRAPH AT		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
	8	9525.	3152.	795.	764.	7.00
ROUTED TO	88	7156.	2744.	782.	751.	7.00

100 - 1221 = 879